Attitude Studies by the IAEA/IIASA Risk Assessment Group

O. Renn, E. Swaton*

Program Group: Technology and Society, Nuclear Research Centre Julich, Post Office Box 1913, D-5170 Julich-1, Federal Republic of Germany

INTRODUCTION

Since the beginning of our history, technology and man have been in a state of tension: man has learned to make use of instruments to refine and perfect his non-specialized organic nature in any desired direction. Technology helps him to move faster than any animal, to see, hear, and smell better, to obtain food faster and in greater quantities, to protect himself more effectively against hazards and natural risks, to prolong his span of life, and to ensure continuous propagation of his species. However, a price must be paid for this progress: increasing specialization and differentiation in society result in anonymous and incomprehensible social structures which the individual can no longer understand, technological systems of ever greater perfection and cost increase the risk of being killed by the machine which man himself has created. The acceleration of production efforts creates more and more environmental pollution which, in the final analysis, can destroy the foundations that support human life. Last but not least, technology can also amplify the negative developments in human society: the more efficient our technology, the greater is the potential for catastrophic events when aggression takes place, expressed in terms of crime, terrorism, civil unrest, or war.

There is no doubt that ambivalence towards technology exists. Many types of societies have deliberately forgone any forced advancement of technological progress because the social dynamics associated with the development of new instruments

* IAEA/IIASA Risk Assessment Group, International Atomic Energy Agency, Vienna International Centre, Post Office Box 100, A-1400, Vienna, Austria

NATO ASI Series, Vol. G4
Environmental Impact Assessment, Technology Assessment, and Risk Analysis. Edited by V.T. Covello et al.

would have threatened the static conditions in these societies, (e.g., ancient China). Therefore, in the 19th century, technological progress meant overcoming rigid hierarchies and postfeudal power conditions. Until the past decade, the advancement of science and technology was considered a priority task of society, associated with a highly positive value and progressive image. However, within a short period of time the problems created by major industrial facilities, an increasing awareness of the environment, disillusionment as to the limitations of scientific research and technology in important areas (such as cancer research), employment problems due to automation, and saturation phenomena in the consumer area have initiated a reinterpretation process which has directed the spotlight of perception to the ambivalence of technology. In addition, the concepts for soft or alternative "countertechnologies" have stimulated the increasingly critical discussion on technology and its consequences (1).

In this situation, where cognitive contradictions and a successive change of value orientations and ethics both introduce uncertainty into man's thinking, studies on the perception of technology achieve their special significance. The future development of technologies depends to a large extent on the readiness of society to cope with the new skepticism of its citizens. In particular, the public debate has been focused on energy systems. Should we proceed with building nuclear power reactors? Is it worthwhile to invest into the development of renewable energy sources? How much primary energy can we save, if all means of employing efficient techniques for energy conversion are utilized? Is energy conservation feasible?

These questions cannot be answered exclusively by the expert community. Value judgments, concerns about the future situation of mankind, and political considerations play a major role in the energy controversy. If those parameters are not taken into account, the mere technocratic decisionmaking process will ensure a rise of social opposition. The other extreme, the refusal of factual expertise, leads to a polarization of social groups caused by the inability of the political institutions to play a mediating role between the different factions, since mediation must be based on some solid ground of factual knowledge.

In this dilemma, social studies of energy systems have to serve three functions: 1) They should provide knowledge about the motives and mechanisms of reasoning which shape the public perception of technology; 2) They should evaluate existing or propose new means and techniques to resolve conflicts without pre-determining their potential outcome; and 3) They should

provide a political framework which allows a proper incorporation of facts, values, and ambiguities in the decisionmaking process.

The following article covers only the first aspect. We will report on the attitude surveys regarding various energy technologies which have been conducted under the auspicies of the IAEA/IIASA Risk Assessment Group in various countries. The main purpose of these studies has been the detection of latent patterns which govern the mental process of assimilating and evaluating energy systems. Also, a cross national comparison regarding the structure of salient belief factors is one of the central objectives of the IAEA/IIASA investigations.

A CLASSIFICATION OF RESEARCH APPROACHES TO STUDY THE PERCEPTION OF TECHNOLOGIES

The questions of how individuals perceive technolgies and how they evaluate information about technologies is part of quite a variety of psychological, social psychological, and sociological theories. Psychological theory has emphasized the individual process of common sense reasoning, incorporating the social environment and specific motivational factors. The purpose of this research is directed towards the individual process of understanding the representation and assimilation of technological information and the formation of an overall judgment.

Psychological theory assumes that human beings have specific value clusters which influence the weighting of attributes connected with the perception of a given object. Specific psychological mechanisms of common sense reasoning combine the perceived properties of an object with the relevant attributes which have been weighted by individual values prior to the intuitive assessment process. Depending on the psychological model used, the resulting judgment consists of a linear combination of attributes and perceived consequences or, in addition, is influenced by common sense heuristics to cope with uncertainty (3).

Social psychological research concentrates on the interaction between social environment (social value, norms, and roles) and personal judgment. The perception of technologies is being understood as a process of deriving attributes about specific objects from general social values and personal attitudes and linking these attributes to the perceived properties of the object or technology (4).

According to social psychological theory, the perceived properties of an object are transferred into a belief system in which not only object-related cognitions but also situation-related factors (such as the perception of those people who favor the object) and symbolic attributes (such as national pride) are combined to an overall image of the object. After each of these beliefs has been evaluated by the degree of emotional saliency (good - bad), an overall judgment can be derived (5). Sociological research finally addresses the problem of group responses to technologies, concentrating on the influence of social values, institutional constraints, reference group judgments, communication, and power interchange (6).

The means of combining the beliefs into an overall judgment are of minor interest. The research focuses on the roots of the belief-forming process. If social groups are convinced that they will increase their power or gain more resources (money, status, social influence) they will collect or even create positive beliefs and neglect negative ones. Via reference groups influence, all individuals who feel themselves represented by these groups will adopt this view and will shape their belief-system according to the desired result. The cognitions or attributes which are used to justify the judgment are rationalization-strategies to back up personal or group-related interests. General value commitments and perceptions of the society (general attitude systems) are the intervening factors which, on one hand, determine the definition of gains and losses in the social game of acquiring influence and, on the other hand, structure the arguments to legitimate self-interest vis-a-vis all other groups in society (7).

The sociological approach does not apply to the investigation of the individual reaction towards technologies. Yet it is often said that the study of personal beliefs and evaluations --both domains of psychological or social-psychological research--disguises the real causes of the social perception of technologies because the individual beliefs are more justifications of preformulated social judgments made by reference or interest groups. But the fact that interests, power play, and value conflicts play a role in the acceptance of new risk sources does not contradict the fact that people will "mentally" absorb and assess risk sources with the aid of innate or acquired cognitive processing patterns. Only the consideration of both facts will provide a uniform overall picture of the situation. Thus, psychological research is in a far better position to clarify why it is primarily nuclear energy which is confronted with acceptance problems and not, for example, chemical plants, refineries, or automobiles, while

sociological research is better able to provide information on the problems regarding the organization of protest behavior and the emergence of general resistance (8).

These preliminary remarks seem to be necessary to elucidate the expressive power and also the limitations of psychological and social psychological research. If the process of absorption and the processing of judgment formation with respect to technologies is successfully traced and typical patterns of people's reaction to new risk sources are identified, a first and important step towards classification of relationships between man, technology, and risk will have been taken.

SEU-THEORY VERSUS ATTITUDE THEORY

Among the psychological and social psychological approaches, two main theories have been applied to study human responses towards technologies: the theory of the subjectively expected utility (SEU-theory) and the attitude theory. According to SEU-theory, the relationship between the expected benefit and loss determines the images of technologies which people shape in the course of assimilating information about new objects. This rationalistic approach can be interpreted as a variant of the value-expectation-concept within the framework of the psychological theory (9).

Attitude theory relies more on psychological learning theories (stimulus-response-models). People memorize specific beliefs about objects through communication and personal experience. Those beliefs are summarized to an overall judgment indicating the degree of favorableness towards the object (10).

For the purpose of describing the differences of SEU and attitude theory more accurately, it is necessary to define some key terms which are needed to understand the different approaches.

> Object Perception - Object perception describes the process of mentally representing and assimilating information and experience with respect to a physical object or entity (11).
>
> Values - A value is a conception, explicit or implicit, distinctive of an individual or characteristic of a group, of the desirable which influences the selection from available modes, means, and ends of action (12).

Belief - Belief represents the cognitive images a person has about a given object, i.e., it is a probability judgment whether an attribute is or is not, and to which degree it is associated with the perception of an object. The subjective feeling of goodness or badness which is linked with each attribute refers to the affect a person might have and is called subjective evaluation (13).

Attitude - Attitude is a mental and neutral state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related (14).

Concerns - A concern refers to a state of positive or negative responsiveness of individuals to become aware of and process any information or personal experience regarding salient areas of interest on that matter.

In Fig. 1 we have made an attempt to depict the interconnections between beliefs, concerns, values, attitudes, and perceptions. We have started with five categories: the physical environment, the social environment, the cultural environment, the psychological motives, and the socialized world view. Any individual is confronted with a specific object which is embedded in a social situation and a cultural context (symbolic meaning). The physical properties of the specific object as well as the specific characteristics of the situation are perceived by the individual. The perceived properties are not identical with the real properties. Limited access to information, specialized selection filters, and general concerns govern the perception process. Parallel to the perception of properties, a subjective assimilation of social characteristics takes place: both processes are combined in the subjective assessment of consequences that are seen as associated with the object. Also, at this stage, associations derived from the cultural context or from personal emotion are included.

The next step is the processing of the perceived object properties, situational characteristics, predicted consequences, and associations into a belief system. The selection of what enters into the belief systems, the mode of abstraction from personal experience or concrete information to generalized convictions, and the way of ordering the respective items into salient clusters are influenced by the values,

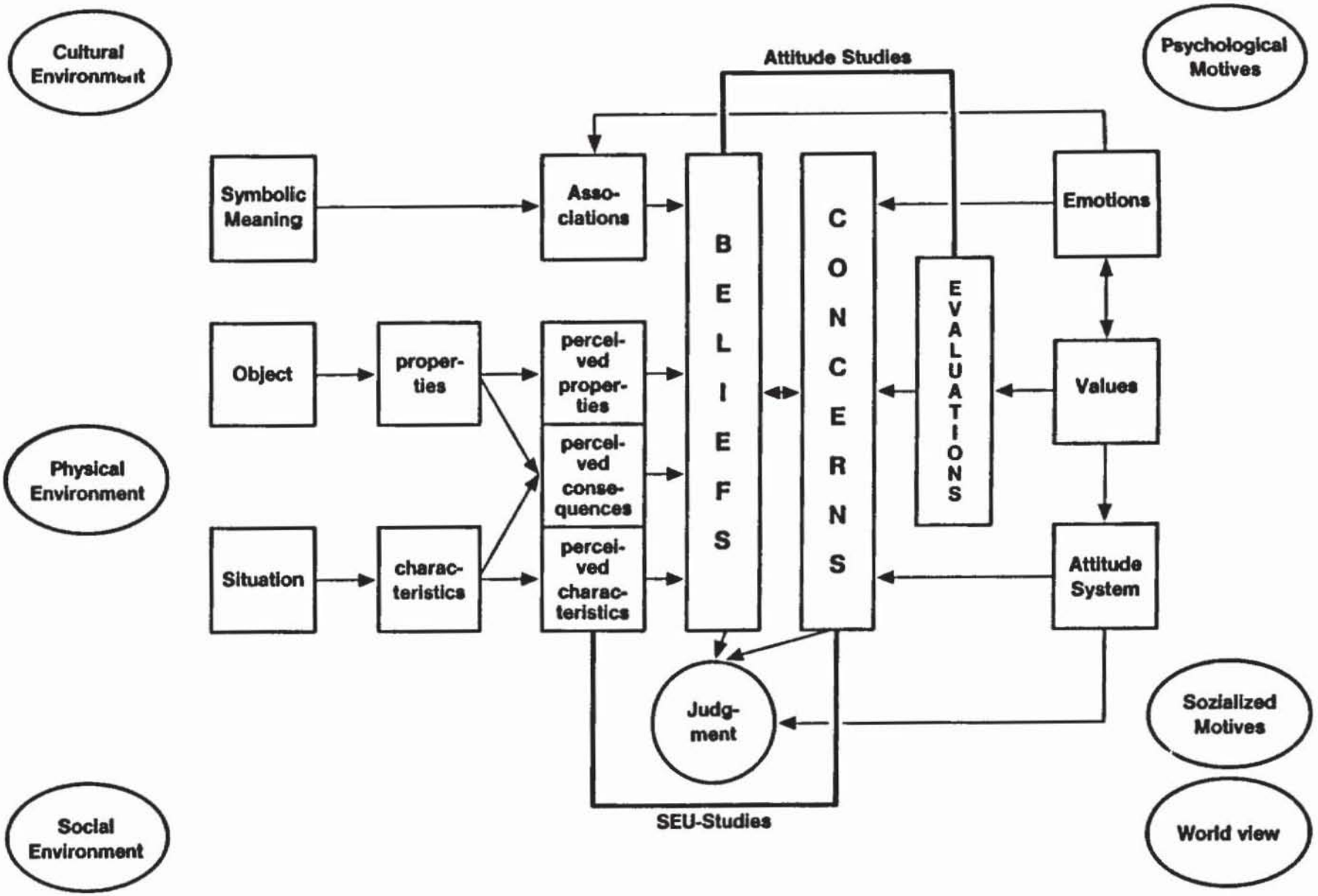

Figure 1: The Mental Process of Technology Perception and the Explanatory Value of SEU and Attitude Theory

emotions, and attitudes towards similar objects via evaluations and concerns.

The last step refers to the process of balancing the positive and negative beliefs aiming towards a general evaluative judgment with respect to the object. For this purpose, the beliefs are ordered according to their subjective importance, the judgments of reference groups are incorporated, the personal consequences of each possible judgment are assessed, and the possible outcome is compared to earlier experience with similar objects.

This outline is, of course, just an analytical tool to understand the process of attitude formation. The different stages are interlinked in the real world and proceed much more unconsciously, as we have pointed out. Yet, it represents a theorectical framework which helps us to direct our research efforts and techniques to the key stations of people's reasoning.

Coming back to the original question regarding the difference between SEU- and attitude theory, we can use the above outline to illustrate the two approaches. SEU-theory combines the level of concerns with the level of perceived properties, characteristics, and consequences. This is done in three steps: 1) We investigate what matters to people, what they are concerned about. The selection of concerns roots in the value orientations and the general attitude system (symbolizing the real world for each individual); 2) we introduce a specific object and ask for the perceived properties with respect to the salient concerns and the probability of their occurrence; and 3) we combine the information via a simple linear or a more sophisticated nonlinear model to predict the overall judgment of a specific person.

The attitude model relies on a very similar procedure but uses a different input. In attitude theory, researchers investigate the beliefs about an object first, and then try to elicit the motivational saliency of each belief by asking for the general evaluations which underly the intention of this belief. Finally, they use different algorithms to combine beliefs and evaluations to determine the direction of attitudinal commitment.

SEU-theory has the advantage that it can be used with objects that are fairly new, because it is based on primary perceptions of properties and general concerns which are not specifically related to the object. It is also more appropriate if the psychological mechanism of perceiving, assimilating, and

processing information about general characteristics of objects such as risk, uncertainty, personal benefits) is to be studied.

Attitude theory applies more to research about the understanding of motives and cognitive reasons which underlie the particular responses of people towards a concrete technology. Studies based on this approach are in general more reliable in predicting an overall judgment with regard to a specific technology. This is the reason why we chose an approach based on attitude theory to investigate the motives and beliefs that determine the mental responses of people towards energy systems.

THE ATTITUDE CONCEPT

After the classification of the different psychological and social psychological approaches to study responses of people towards technologies, it is necessary to give a brief introduction into the various attitude concepts. Otherwise our reasons for choosing the Fishbein approach for our own investigations will not be understandable.

The first differentiation among attitude concepts was made between defining the term attitude as a physiological readiness of the body to react as opposed to conceptualizing the same term as a mental state. Since somatic reactions turned out to be undecisive with respect to their psychological meaning, only the mental concept of attitude survived. Measuring finger pulse, galvanic skin responses, or heartbeat rates does not indicate any specific response towards an object, but merely reveals the existence of psychic tensions which might have different reasons and call for various interpretations. Therefore, attitude research at present relies mainly on oral responses or observations of behavioral reactions.

After this issue has been settled, a new controversy came about between the mediative and behavioristic schools. According to the mediative approach, attitude refers to a mental state of favorableness or unfavorableness towards an object exerting a dynamic incentive to behave accordingly (15). The behavioristic school defines attitude as the probability of similar behavior towards an object in similar situations (16). Whereas the behavioristic approach has only been interested in the consistency of overt behavior, leaving aside the underlying mental causes and reasons (black box), the mediative approach intends to investigate the mental process of constructing a relationship between a subject and an object regardless of

whether this relationship will be transferred into an observable action (17). Over time the behavioristic approach has been contested because 1) Attitudes towards objects may exist in spite of any overt behavior ever having taken place (e.g. prejudices against foreigners, etc.); 2) Behavior is not only determined by attitudes toward an object or an action, but also is influenced by a set of other aspects which range from personal characteristics to social roles; and 3) The actual behavior is influenced by external parameters (situaton, object, time).

These obstacles cannot be compensated by the advantage to include an operationalized measurement of attitudes within the theoretical definition.

In contrast to the behavioral concept, the mediative refers to the process of mental processing of external stimuli. Shaw and Wright hold that "Attitude refers to a relatively enduring system of evaluative concepts of beliefs which have been learned about the characteristics of a social object or a class of social objects" (18). The problem here is the difficulty to operationalize a mental state.

Within the general framework of mediative attitude definitions, there are different concepts depending on the number and structure of components which determine attitude. The classical consistency theory distinguishes three equally important components: cognitive, affective, and conative.

The cognitive component refers to all the beliefs that a person connects with a certain object; the affective component describes all the emotions and evaluations that are interlinked with the beliefs; and the conative component summarizes all the behavioral intentions which will probably occur if the person faces a situation in which these intentions are a socially accepted way of reaction. Classical consistency theory assumes that individuals try to order beliefs, emotions, and intentions in such a way that a consistent system of positive and negative feeling is developed which can be comprised into an overall judgment. This judgment is a decisiive factor for one's own action (19).

This classical approach was altered by other theories. Rosenberg, for instance, divided attitudes into two segments: cognitive beliefs and affects. Those two components form the central inputs for the overall attitude, but at the same time the more peripheral determinants of the readiness to act according to the overall feeling are relevant. Behavior is also influenced by innate and situational factors, which are unrelated to one's own perception of the object (20).

It is to Rokeach's credit to have pointed out the distinction between beliefs referring to an object and those referring to the situation in which the object is introduced. When comparing the SEU and the attitude models we already mentioned the difference between the perception of the object itself and its social circumstances--both perceptions constitute the subjective assessment of consequences. According to the model of Rokeach, the beliefs connected with the object and the beliefs connected with the situation are combined to a holistic judgment (21).

A multidimensional attitude theory has been developed by Triandis. The starting point of this model is a complex reality which shapes the cognitive structure and the affective evaluations by learning processes. Behavioral intentions are loosely intercorrelated with these socialized patterns of perceptions, but they are more thoroughly influenced by other factors, such as personal properties, behavior of reference groups, or social norms. The actual behavior is a function of the strength of the attitude (not its direction), the behavior intentions and other situational variables (22).

Finally, we should mention the theorectical work by Vroom who set up a rather similar approach to SEU-theory. According to his model, beliefs can be substructured into instrumental, probabilistic, and consequential aspects. These aspects are evaluated by the valence of values and emotions and transferred into an attitude (23). An illustration of the basic features of all consistency models can be seen in Fig. 2.

As a viable alternative to the consistency models, other concepts have been proposed which regard attitudes as a composition of emotionally evaluated beliefs (24) based on the following definition: "A person's attitude toward any object is a function of his beliefs about the object and the implicit evaluative responses associated with these beliefs" (25). The attitude theory developed relies on the following assumptions (26): 1) Any given object is related to various attributes; 2) Associated with each of the attributes is an implicit evaluative response, i.e., an attitude; 3) Through learning and experience, these evaluative responses are associated with the attitude object; 4) These evaluative responses summate; and 5) On future occasions the attitude object will elicit this summated evaluated response, i.e., the overall attitude.

If these assumptions are regarded as valid, attitudes can easily be elicited by collecting data on beliefs about the respective attitude object and the evaluative weight given to each attribute. Other unidimensional attitude models rely

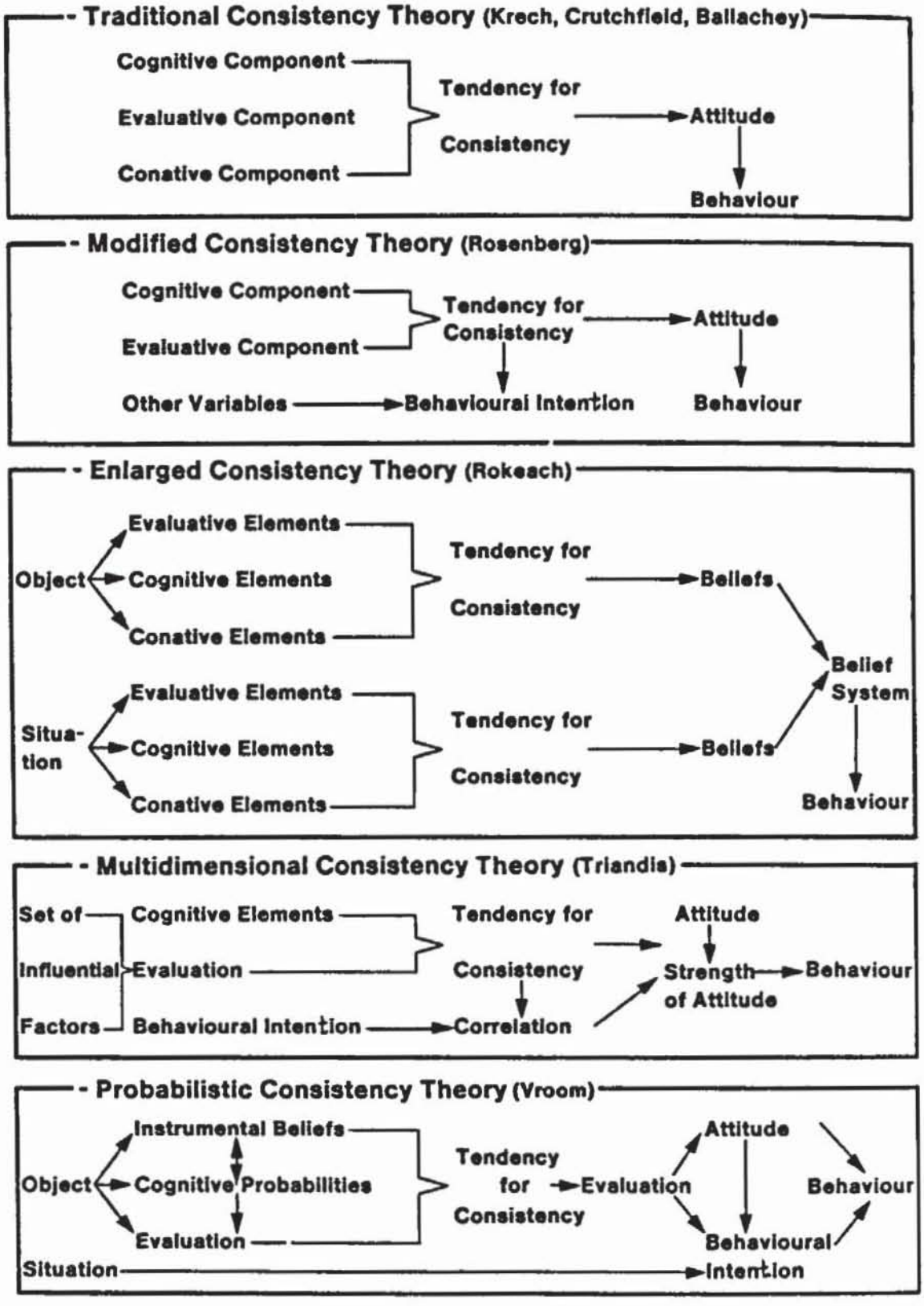

Figure 2: A Review on the Basic Assumptions of Consistency Theories on Attitudes and Behaviour

solely on the composition of affective statements about the object in question.

Figure 3 summarizes the relations among beliefs, attitudes, intentions to perform specific behaviors, and behavior. A good explanation of this figure has been given by H. Otway in an article on risk perception:

> "We can see that a person holds many beliefs about each attitude object, i.e., he has "learned" a number of "facts" about it. But this attitude only pre-disposes him to behave in a consistent way with respect to that object when a large number of behaviors are observed. Attitude does not pre-dispose him to perform any specific behavior with respect to that object, and thus attitude would not be expected to show any relation to some specific behavior. However, to repeat, the attitude toward the object is of interest because it gives us an indication of the overall pattern of behavior with respect to the object." (27)

By comparing the different attitude models, it seems evident that the multidimensional approaches have a more complex and realistic theorectical base, but encounter enormous problems in establishing an appropriate measurement technique. In particular, the composition rule for combining the different dimensions into one holistic judgment cannot be derived by theorectical assumptions and is open to subjective variations. However, the simple affective scales to measure attitudes cover only partially the complexity of attitudes and have empirically been proven as bad predictors for general behavior (28).

As a good compromise between the theoretical complex multidimensional attitude concepts and the simple affective concepts based upon a single-scale measurement, we decided to choose the in-between model of Fishbein which covers at least two dimensions of attitudinal patterns and provides for a precise and well interpretable measurement procedure. The general drawback of the Fishbein model is the assumption that no response biases exist among the beliefs and that no interaction takes place between the evaluation and the beliefs. It is evident that in reality this cannot be accomplished. In practical research, however, a feasible solution is to state a general thematic frame prior to the

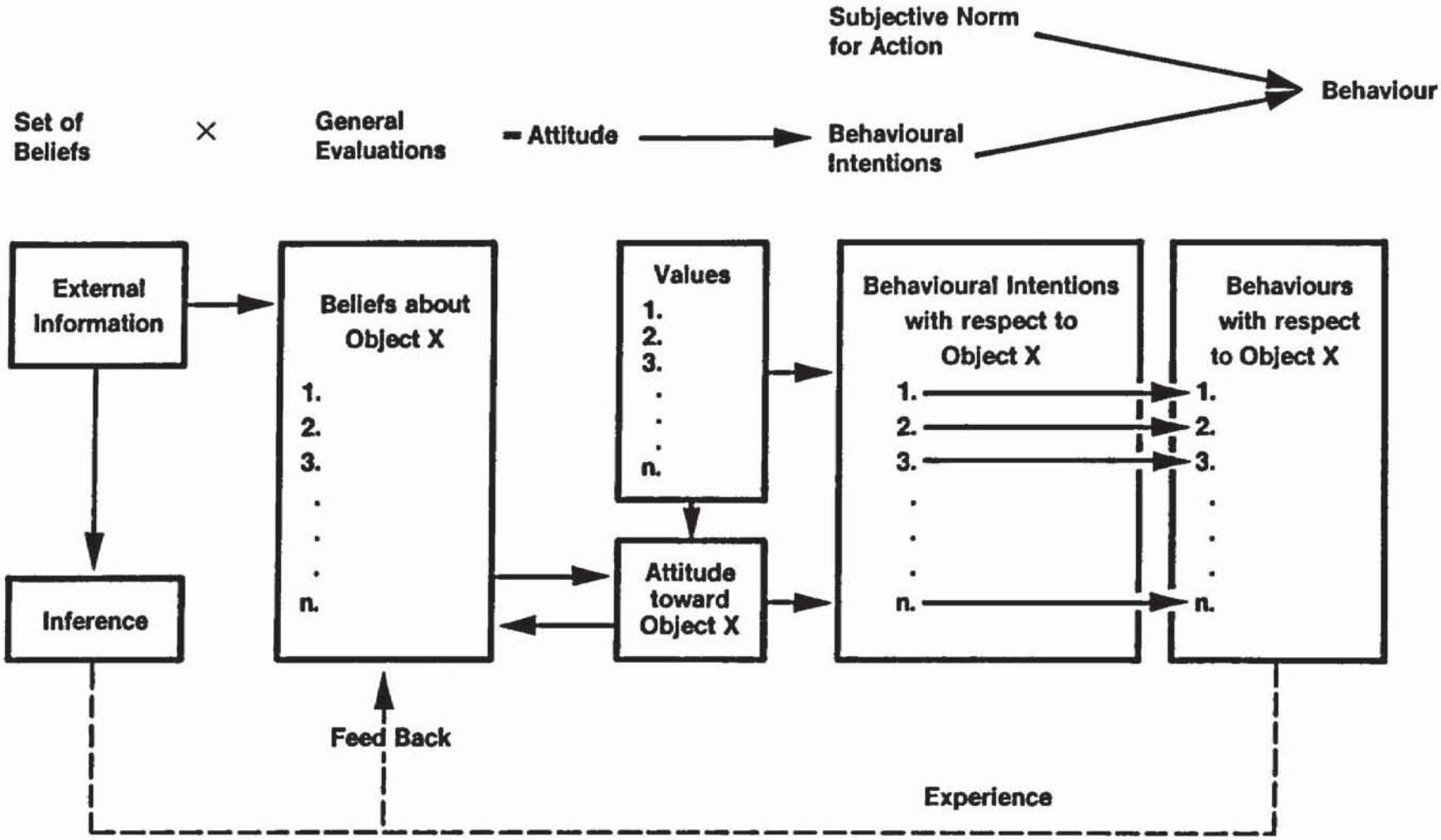

Figure 3: The Relations between Attitudes, Beliefs, Behavioural Intentions and Behaviour According to Fishbein

measurement of evaluations and to introduce the concrete attitude object only when the beliefs are presented. The intercorrelations among beliefs can be detected by using special statistical techniques like multiple stepwise regression analysis. Another advantage of the Fishbein model is its applicability for comparisons between samples from different nations since the formalized concept can be transferred to different culture contexts without opressing cultural variations in reasoning and object perceptions.

GENERAL METHODOLOGY OF THE FISHBEIN TECHNIQUE

According to the attitude theory of Fishbein and Ajzen, a person's attitude toward any object is a function of his beliefs about that object and the implicit evaluative responses associated with those beliefs.

Formally, beliefs and attribute-evaluations are combined as follows:

$$A_o = \sum_{i=1}^{n} b_i e_i \text{ where}$$

A_o is the attitude toward the given object,

b_i is the belief about this object, expressed as subjective probability that the object is related to attribute i;

e_i is the evaluation of attribute i; and

n is the number of beliefs (units of information) a person holds about the attitude object in question.

This formal representation of the model suggests a twofold measure of attitude. Since the sum of the belief-evaluation products represents an indirect measure of attitude, this measurement can be validated by a direct approach to measure attitude. The technique selected for this purpose is the "Semantic Differential" developed by Osgood, et al. (29).

With this method, the respondent is presented with a series of seven-place bipolar adjective scales. The end-points are defined by adjectives which have generally been shown to have evaluative connotations; e.g., good-bad, harmful-beneficial. The respondent is asked to rate the object by placing a check mark at the point on the scale which he feels indicates the

appropriate description. A direct measure of attitude is obtained through summating over the responses to this set of bipolar adjectives which have an evaluative connotation with regard to the given attitude object.

The correlation coefficient between the direct and indirect measurement demonstrates the reliability of a chosen set of attributes as relevant units of information.

A further test of the validity of the Fishbein scaling technique can be carried out by asking the respondents directly what their feelings are considering the perceived properties of a given object. This direct measurement of the attitudinal commitment can also be correlated with the indirect measurement by the Fishbein algorithm.

Thus, several separate and independent measures of attitude are available: the sum of the eb-products, interpreted as an indirect representation of attitude; the sum over the ratings of the adjectives of the semantic differential interpreted as a direct representation of attitude, and finally, attitude by the direct scale (PRO/CON scale) where respondents simply indicate their degree of liking or disliking of the attitude object.

THE APPLICATION OF THE FISHBEIN TECHNIQUE TO ENERGY SYSTEMS

Design of a questionnaire pertaining to the Fishbein technique requires a careful selection of the attributes. The development of the questionnaire for the IAEA/IIASA studies underwent the following stages: a first version was put together after extensive screening of mass media and relevant literature. In addition, some 100 persons in Vienna were interviewed about what came to their mind when they thought of "nuclear power." Particularly this interview procedure is of considerable importance because it permits the researcher to select those concerns which are forwarded most often (in Fishbein-terminology, overall salient beliefs). Although a person's attitude will be determined by only a few salient beliefs, it is necessary to use a larger set of relevant beliefs in order to detect particular clusters of beliefs among various social groups. The identification of underlying determinants of attitudes via statistical procedures, like factor analysis, also requires a larger amount of items for the deduction of valid results. A number of 30 to 40 different beliefs seems to be sufficient to meet both requirements.

Accordingly, a pilot questionnaire was designed and applied in Austria to a stratified sample (30). The next step implied some modifications of the original version of the quesionnaire so that it could be applied in other countries as well which meant the inclusion of issues which has been repeatedly raised in different countries. Furthermore, the questionnaire was extended by another form of evaluating the beliefs. All items were again to be judged, but now from the point of view of how important these issues were perceived to be in the ongoing energy debate. This, we felt, would permit not only a better understanding (cross-validation) of the relevance of the selected items and the role these issues have in acceptance or rejection of energy technologies, but also provide an interesting means of comparison between different samples in cross national comparison.

After the necessary pretests, the questionnaire used in later studies consisted of five parts, each having separate instructions. All instructions were written on the questionnaire, permitting application to groups of respondents instead of single face-to-face interviewing. Running through the whole interview takes between 30 to 90 minutes, depending on the speed of the respondent's decisionmaking and the number of energy systems included.

The first part of the questionnaire is devoted to elicit the attribute evaluations, where respondents express their subjectively felt goodness or badness of each of the 30 attributes. The verbal anchoring of the scale for this part is "good-bad." For example:

Promoting my nation's industrial development

BAD: ___: ___: ___: ___: ___: ___: ___: GOOD
very quite slightly don't know slightly quite very

It should be noted that here the attributes are presented without reference to any specific energy source.

In the second part of the questionnaire, the same 30 attributes are presented, but now linked with the attitude objects for each of the selected energy systems. This belief strength is measured again on a bipolar seven-place scale with the end points now labelled "unlikely-likely." The respondent is asked whether and how strong the attribute is related to the attitude object. For example:

The use of nuclear energy promotes my nation's industrial development

UNLIKELY: ___: ___: ___: ___: ___: ___: ___: LIKELY

This part is repeated separately for each energy source under investigation.

The third part is designed using the techniques of the Semantic Differential, as described above. Here each bipolar seven-place scale has a different verbal anchoring, namely pairs of adjectives found meaningful to describe an energy source. Sixteen pairs of adjectives were selected and again each energy source was rated separately.

The next section of the questionnaire (part 4) was designed to explore the awareness of respondents about those issues which are prevalent in the discussions about acceptance of nuclear energy. Thus, emphasis in this part is given to the level of information of respondents rather than their personal attitudes, and can be used as a means for cross-checking the salience of the attributes selected. The instruction given for this section asks the respondents to indicate their opinion about the importance of the 30 statements with regard to the ongoing discussions about the use of nuclear energy. Again, a seven-place scale is used whose end points are labelled "very unimportant-very important." For example,
Being harmful to future generations

VERY UNIMPORTANT	___:	___:	___:	___:	___:	___:	___: VERY IMPORTANT

Results derived from these importance ratings lend themselves to interesting comparisons with samples from other countries because the level of awareness and information is indicated. Furthermore, a lack of information (e.g., about particular benefits) can be detected.

Subsequently, a straight forward measure of the personal opinion about nuclear energy (PRO/CON scale) is elicited on a 7-point scale with the labels "very unfavorable-very favorable." Part 5 of the questionnaire is devoted to demographic information such as sex, age, years of schooling, occupation, etc.

CROSS NATIONAL APPLICATION

During the 1970s the questionnaire was translated into German, Spanish, French, Portuguese, Finnish, and Japanese. Psychologists and social scientists from various countries have been trained to use the Fishbein technique and to conduct surveys in their countries. So far data on attitude towards the use of nuclear energy have been collected from Brazil,

Colombia, Japan, the Philippines, Austria, Finland, and the Federal Republic of Germany. Similar questionnaires have been used in France and Canada. The main purpose of all these studies is to gain a better understanding for controversial issues and to identify underlying basic social values which guide the evaluation of various beliefs. In particular, national or cultural differences in perceiving the same object might give some insight information about the structure of the individual perception process. Some unique features seem to play a decisive role in almost all countries (such as safety, long-term risks, and indirect economic benefits), wereas others turn out to be rather specific with respect to national particularities.

Cross-national surveys always run into the difficulty of finding appropriate samples which allow comparisons between countries. Any comparison relies on at least one common denominator for which differences can be identified and measured. Because countries differ in their cultural heritage, their social structure, and their economic system, it is essential to base comparative research on a fixed and constant parameter that holds true for each of the observed countries and can be used as a yardstick to interpret deviations between countries in a meaningful way. Such a common parameter might be an equal degree of knowledge, a share of common values, or a homogeneous structure of social positions. Because attitudes on energy systems are not independent from the level of object-related knowledge (which varies from country to country) and because there is no indication that nuclear energy is perceived in terms of indentical values, it is necessary to restrict the scope of social positions in order to create a homogeneous background for comparisons.

As long as rather similar countries are selected for the analysis of attitudes, a survey based on random sampling of the general public can be used. For the purpose of cross national survey between nations of different cultural background, the range of social positions has to be predefined to end up with comparable samples. In this case we confined our samples to students of technical and natural sciences, opinion leaders, politicians, or other educated classes. Nevertheless, the attitudes of the general public in each participating country were also measured to compare the results of these surveys with the finds of the elite samples. This comparison--if restricted to one country or culture only--is a valid and useful instrument to investigate the gap between the perceptions of the general public as opposed to those of technical or cultural elites.

STATISTICAL METHODS OF DATA PROCESSING

Apart from the normal statistical procedures such as frequency distribution analysis and correlations, three more sophisticated methods have been applied to reduce the large amount of variables to a smaller number of salient elements. The techniques involved are factor analysis, multiple regress, and discriminant analysis.

Factor analysis is a method used to determine the underlying cognitive structure in a given set of attributes by comparing the similarities of variance distributions resulting in a combination of items with high intercorrelations. The main purpose of a factor analysis is to derive dimensions which are inherent in a larger set of items.

Multiple regression indicates the strength of a relationship between one dependent variable and a set of independent variables whereby the intercorrelations between the items of the independent variable set are excluded from the analysis. This procedure explains for each independent variable (e.g., attribute) the additional amount of the declared variance of the dependent variable (e.g., semantic differential as a direct measurement).

Discriminant analysis provides a viable yardstick for evaluating the relative distance between various sub-groups of a given sample. A whole set of possible discriminative variables can be investigated and the result of the analysis reflects the relative significance of items as explanations for group differences.

A BRIEF ILLUSTRATION OF THE FISHBEIN TECHNIQUE: THE AUSTRIAN STUDY ON NUCLEAR ENERGY

In the earlier studies of the Austrian public and Austrian decisionmakers (31), the original 39 belief items were subjected to factor analysis to explore the underlying dimensions which characterize the salient determinants of people's feelings towards nuclear energy. This factor analysis produced a factor structure consisting of four belief clusters: Factor 1, psychological risk; Factor 2, economic and technical benefits; Factor 3, social-political risks; and; Factor 4, environmental and physical risks.

Two groups were subsequently drawn from the total sample representing the most pro-nuclear and anti-nuclear respondents. Table I shows the contributions made to the formation of the opposite attitudes by each of these dimensions. The pro-nuclear attitude is largely due to the contributions of factors 2 and 4 and thus rely on the technical, economic, and environmental considerations. The anti-nuclear commitment can be best explained by factors 1 and 3, concentrating on the psychological and sociopolitical aspects of nuclear energy. The strongest differentiation between the two groups is the psychological risk dimension (30).

Table I: Contributions Made to Attitude by Each Belief Dimension

(Public Groups)

Dimension	Attitude contribution (Range ± 9)	
	Pubpro (n = 50)	Pubcon (n = 50)
Psychological risk	− 1.6**	− 6.4
Economic-technical benefits	+ 3.2**	− 0.2
Socio-political risk	− 1.2*	− 3.2
Environmental risk	+ 1.9**	− 1.4

* Difference significant at 0.05 level
** Difference significant at 0.01 level

In order to validate these finds, the sum of all evaluated beliefs were correlated with the semantic differential measure. The correlation coefficient of $v = 0.63$ is highly significant. Also, the sum over the factor items was correlated with the semantic differential measure (for the purpose of demonstrating the validity of the factor structure), resulting in a coefficient of $r = 0.66$.

Thus, we feel justified to conclude that the main reason for people in Austria to oppose or favor nuclear energy is the saliency of psychological and sociopolitical aspects. If persons are convinced that nuclear energy poses "psychological" risk on their life (such as delayed effects, nonsensible dangers, no personal control), and that at the same time sociopolitical impacts of this technology exist, a negative attitude is likely to be formed regardless of how the physical and environmental risks are perceived (31). This application of the Fishbein model illustrates its usefulness in explaining different responses of people towards energy technologies.

Next, we will describe in more detail a comprehensive study on attitudes towards nuclear power, comparing students in three different countries. This description is intended to outline the distinct steps of a case study and to provide an understanding for the method, its application, and its potential.

A CASE STUDY: A COMPARISON OF ATTITUDES IN THREE NATIONS TOWARDS NUCLEAR POWER

During the time from 1978-1982, three surveys of students from Technical Universities in the Federal Republic of Germany (FRG), Japan, and the Philippines were conducted using the questionnaire which was developed by the IAEA/IIASA Risk Assessment Group (32). All necessary translations were made by bilingual social scientists; several pretests proved the validity of the translation.

As previously indicated, international comparison demands a certain degree of homogeneity with respect to the selected samples if the issue of the survey is related to either experience or knowledge. Since attitudes on energy systems rely partly on the level of knowledge, we decided to confine our samples to students of technical and natural sciences. We assumed that students of these disciplines have at least a basic understanding of the functions and purposes of different energy systems regardless of their country of origin.

COMPOSITION OF THE SAMPLES

Three student samples were taken from Technical Universities. The German students were enrolled in Aachen and Cologne (N = 150), the Philippine students in Manila (N = 174), and the Japanese students in Tokyo (N = 36) and Osaka (N = 84).

With regard to sex distribution, the sample from FRG consisted of 63 percent males and 37 percent females, from the Philippine 26 percent males and 69 percent females (5 percent of the sample did not indicate their sex in the questionnaire); and in Japan 96 percent males and four percent females responded to the questionnaire. The age distribution for the three samples is given in Table II.

Table II: Age Distribution of the Three Samples

	FRG		PHILIPPINES		JAPAN	
Age Categ.	Absolute Values	Percent	Absolute Values	Percent	Absolute Values	Percent
18-29	94	62.7%	124	71.3%	107	89.9%
30-45	55	36.7%	18	10.3%	11	9.2%
46-59	1	0.7%	2	1.1%	1	0.8%
Missing Cases			30	17.2%	1	0.8%

VALIDATION OF THE MODEL

As indicated in the description of the Fishbein technique, the significance of the belief items can be tested by correlating the indirect measurement represented by the sum over the evaluated belief items with the direct measurement which is defined as the sum over the relevant adjectives of the semantic differential. The second direct measurement, the pro/con scale, is also included. This was done for the three samples separately. Table III shows the correlation coefficients between the two direct attitude scores (PC, ΣSD) and the indirect measure (Σeb).

Table III: The Correlation Coefficients between Direct and Indirect Measurements of Attitudes (Model Validation)

Attitude Measures	JAPAN	PHILIPPINES	FRG
PC -Σeb	0.59684	0.47485	0.73599
PC -ΣSD	0.71027	0.65471	0.86473
Σeb -ΣSD	0.68520	0.52331	0.81172

All correlations are significant on the one percent probability level, indicating that the design of the questionnaire represents a valid instrument for investigating attitudes. The differences of the correlation coefficients between the three samples can be attributed to the specific variance distribution of each sample.

Examination of Fig. 4 where the respondent frequencies are given in percentages for each response category for each sample, shows that the Japanese students were predominantly for the use of nuclear energy (categories 2 and 3 account for 68 percent of the sample); the Philippine student sample includes two groups, one very opposed (category -3 accounts for 25 percent) and one slightly in favor (category 1 represents 20 percent). The FRG students are also composed of two groups, with 45 percent of the sample being for the use of nuclear power (categories 2 and 3), and a smaller group of 25 percent (categories -3 and -2) being against.

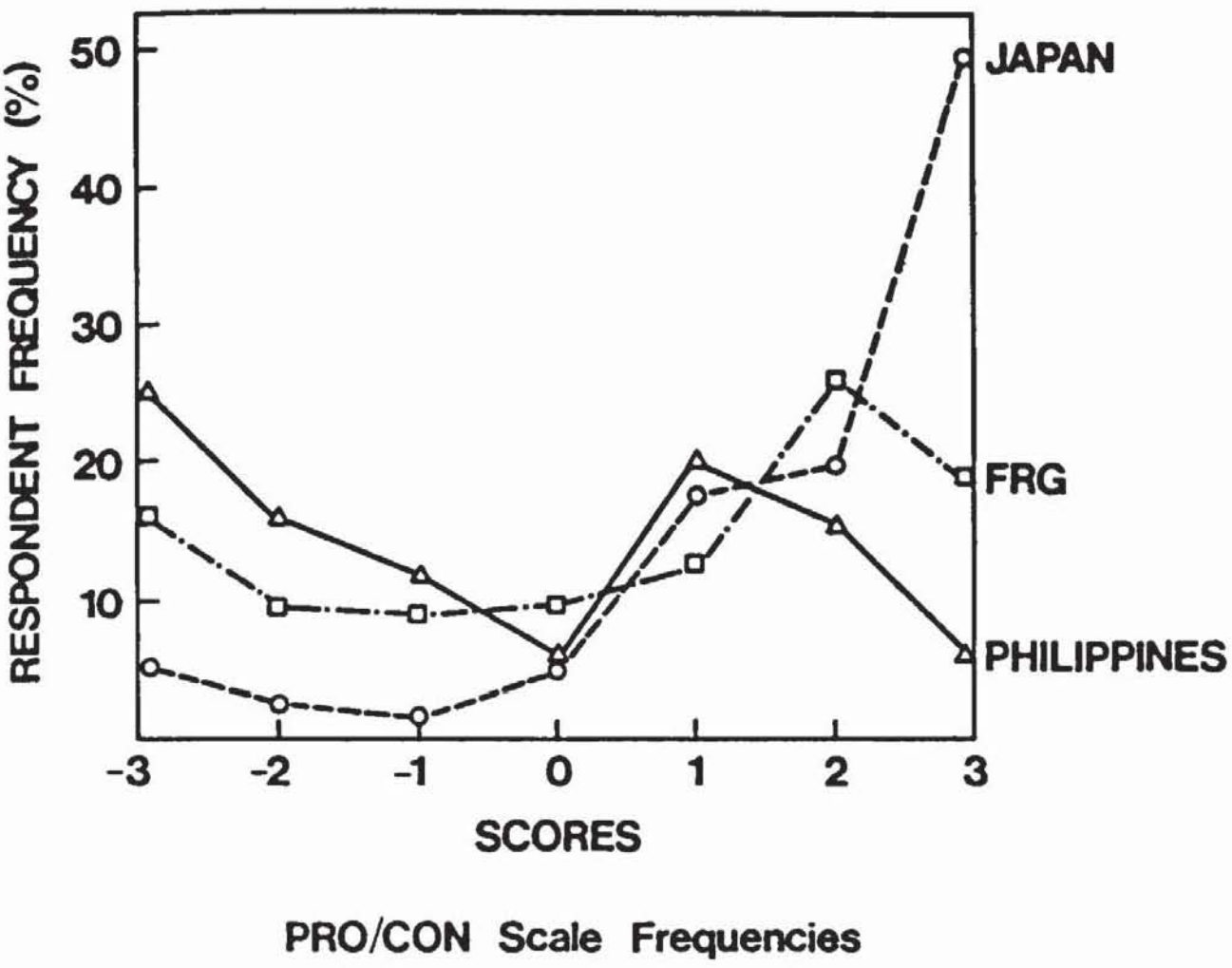

Figure 4: The Frequency Distribution of the PRO/CON Scale Referring to Nuclear Energy

As a general remark it can be noted that except for the Japanese students who are predominantly in favor of the use of nuclear power, the other two student samples from FRG and the Philippines appear to include both interest groups, proponents and opponents.

The second direct attitude measure available is the adjectives of the semantic differential. Figure 5 shows the mean scores for the three samples. The favorable Japanese resondents see the use of nuclear energy as very important and useful, quite good, modern, and worthwhile, but also realize that it is quite controversial and slightly dangerous. In contrast to this relatively clear perception, Philippine students view the same concept as quite wrong, oppressing, and useless. FRG students have the least strong feelings about the use of nuclear energy, perceiving it as quite modern and useful, slightly important, and worthwhile, but slightly dangerous.

Taking the three samples together, the students agree that nuclear power is important, worthwhile, and good, but also that it is dangerous, oppressing, and controversial. Some clue for interpretation of the attitudes of the respective samples might be the fact that there is no nuclear power plant in operation and only one in construction in the Philippines, whereas there are about 15 nuclear power plants operating in the FRG and 24 in Japan. Respondents from these two countries seem to have a more positive attitude towards nuclear energy.

THE BELIEF STRUCTURES

After having established the composition of the various samples with regard to their orientation PRO or CON the use of nuclear energy, the following analyses concentrate on identification of determinants for these attitudes.

Application of factor analysis to the belief scores is expected to reveal the cognitive structure of the respondents concerning their perception of the issues pertaining to the use of nuclear energy. The method used is principal component analysis with subsequent Varimax rotation. This technique produces underlying dimensions which are independent, i.e., orthogonal factors. Since the three samples differed in their attitudes towards nuclear power, it is not anticipated that the factor structures will be identical. Nevertheless, the clustering of items with high intercorrelations could be an informative indicator for general issues of interest in the respective societies.

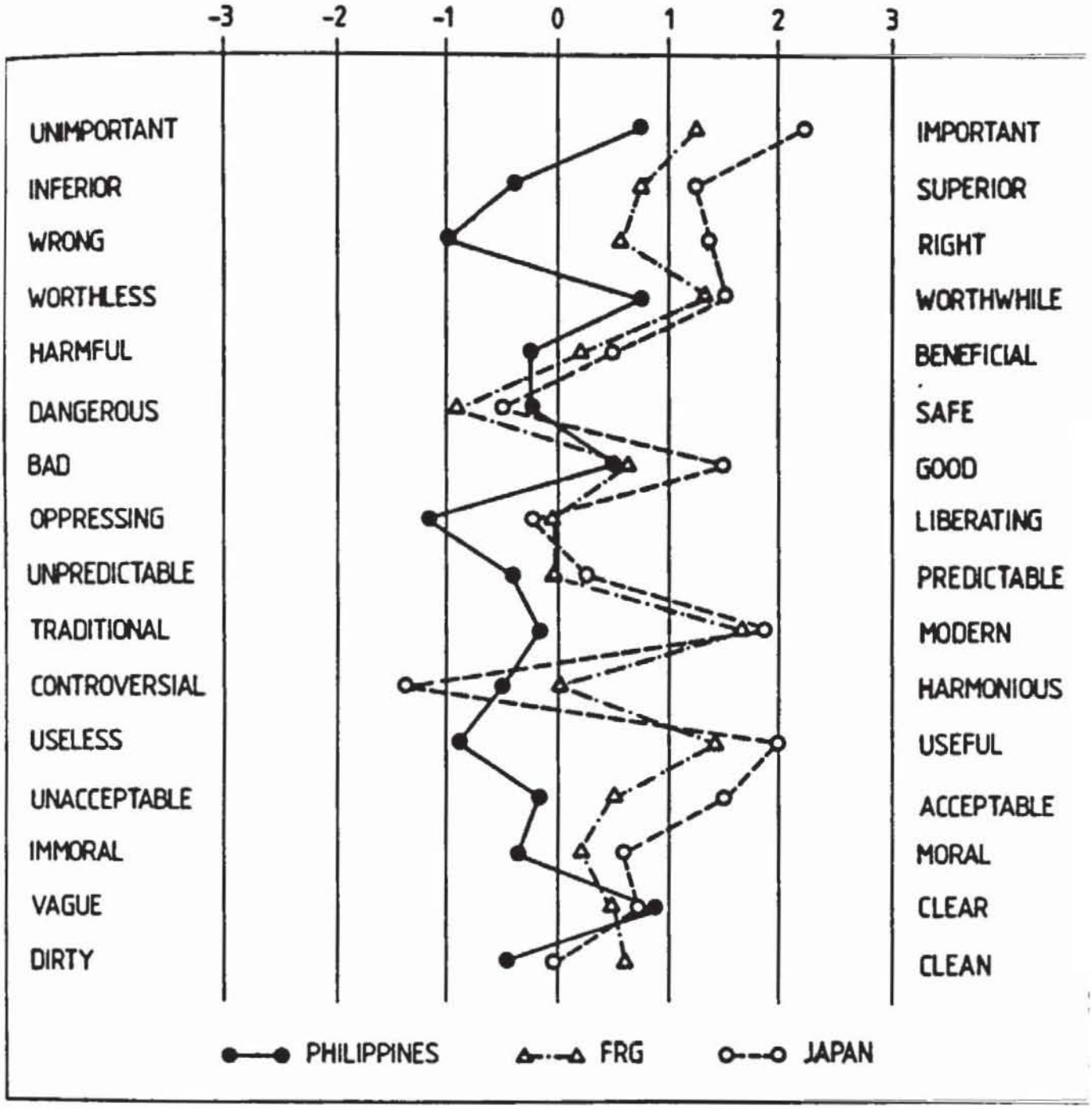

Figure 5: Means of the Semantic Differential to Characterize Nuclear Energy

Philippines

The result of factor analysis of the belief scores on nuclear energy are given in Table IV. Items with high intercorrelations cluster around two aspects, the risk considerations and the benefits, whereby the latter are distinguished by having an effect on the national level or a rather personal level.

Factor I represents the strongest concern with an eigenvalue (i.e., explanatory power for overall variance) of 7.15 and has been labelled: "negative impacts of large-scale technology." The issues involved include the lack of active control over the hazard and the involuntary exposure to it, the concern about large accidents, and the health hazards created, whether directly or indirectly through burdening the environment.

Factor II comprises issues of national interest such as progress and industrial development, prestige, and stimulation of research and has been termed "progress in national development." This factor has an eigenvalue of 3.93.

Factor III seems to represent the more personal benefits respondents attribute to the use of nuclear energy. Thus, the leading items for this factor are referring to the economic production of electricity and the capacity to cover the energy needs on a long-term basis. Another aspect of personal concern, the provision of jobs, is also included in this factor, labelled "fringe-benefits." The eigenvalue of this factor is 3.27.

In order to determine the influence of the cognitive structure on the attitudinal commitments, a multiple regression analysis was undertaken with the semantic differential as dependent and the factors of the belief systems as independent variables. The purpose of the regression analysis was to detect the order of influential strength of each independent variable for the explanation of the dependent criterion. The stepwise procedure of the regression assures that only then will an independent variable be included in the analysis if it significantly adds to the amount of variance already explained by those variables which have been selected through the analysis so far.

For the samples from the Philippines it can be demonstrated that the best predictor for the sum of the semantic differential is Factor III, named "fringe-benefits" ($r = 0.54$; $p \leq 0.01$). This factor is followed by the other benefit-related factor, "progress in national development" ($r = 0.51$, change in R^2) $= 0.12$; $P \leq 0.01$).

Table IV: Factor Structure of Beliefs (PHILIPPINES)

FACTOR LOADING	BELIEF STATEMENT: THE USE OF NUCLEAR ENERGY...
	FACTOR I: Negative impacts of large scale technology
.87	...exposes people to hazards which they cannot influence by any actions of their own
.78	...involves hazardous agents which cannot be detected by man's senses
.78	...leads to accidents which affect large numbers of people at the same time
.74	...leads to environmental pollution
.71	...has an impact on people's health
.71	...leads to dependency on small groups of specialists
.70	...is harmful to future generations
	FACTOR II: Progress in national development
.84	...leads to technological progress
.81	...promotes my nation's industrial development
.78	...increases my nation's prestige
.64	...prevents brown-outs*
.57	...stimulates scientific and technological research
	FACTOR III: Fringe-benefits
.78	...provides a cheap energy source
.67	...is a long-term solution to energy needs
.60	...leads to a more even distribution of income among nations
.55	...helps to conserve natural resources
.53	...leads to increased employment

*item only included in Philippine survey

Factor I "negative impacts of large-scale technologies," seems to play only a minor role with regard to their attitudes, since the single correlation amounts to only r = 0.31 ($P \leq 0.01$) and the additional amount of declared variance is below one percent (P = 0.12). Considering the composition of the sample (about 50 percent pro and 50 percent con, see Fig. 4) it is interesting to note that it is the two benefit factors which seem to be the predominant aspects in the attitude formation of the Philippine sample.

Federal Republic of Germany

Factor analysis of belief scores on nuclear energy of FRG students yielded four factors as shown in Table V. Only one of these factors emphasizes the benefits of nuclear energy, whereas three express concern about the various negative consequences of this energy source. The beneficial aspects cluster in Factor I, "economic progress," whose eigenvalue of 6.33 indicates that a relatively large part of the total variance is explained by this factor. Items refer to cheap electricity production, improvement of standard of living, and various benefits on a national level.

The second factor with an eigenvalue of 4.78 is very similar to Factor I of the Philippine students. Thus, the same labelling, "negative impacts of large-scale technology," was used.

Factor III represents a collection of concerns which could develop into a threat, probably not tomorrow but in the near future. Therefore, it is described as "potential for threat," including issues such as terrorist activities, passive exposure, international conflicts, and the long-term radioactivity of wastes. The eigenvalue of this factor is relatively low, 2.48.

The possible impact of nuclear power on society is expressed in Factor IV, "restriction of social flexibility," with an eigenvalue of 2.42. Items loading high on this factor refer to the possibility of a restricted societal development and the dependency on big industry and its highly specialized professionals.

Computation of multiple regression coefficients as indicators for the attitudinal commitment revealed that in contrast to the Philippine sample, the perception of "negative impacts of large-scale technologies" turned out to be the predominant factor attitude as determined by the direct measurement. The simple correlation was r = 0.83 (P 0.01). "Economic

Table V: Factor Structure of Beliefs (FRG)

FACTOR LOADING	BELIEF STATEMENT: THE USE OF NUCLEAR ENERGY...
	FACTOR I: Economic progress
.75	...provides a cheap energy source
.75	...improves our standard of living
.71	...assures the economic independence of my country
.68	...promotes my nation's industrial development
.62	...leads to technological progress
	FACTOR II: Negative impacts of large scale technology
.74	...leads to environmental pollution
.68	...has an impact on people's health
.64	...leads to accidents which affect large numbers of people at the same time
.63	...has a long-term impact on climate
.60	...is harmful to future generations
	FACTOR III: Potential for threat
.71	...provides a source of threats from terrorists
.59	...exposes people to hazards which they cannot influence by any actions of their own
.44	...involves a technology which is usable as a tool in international politics
.42	...postpones the development of alternative energy sources
.41	...requires management of dangerous wastes
.40	...restricts personal freedom through rigorous security measures
	FACTOR IV: Restriction of social flexibility
.67	...leads to consumption-oriented society
.56	...leads to dependency on small groups of specialists
.51	...restricts options for future societal development
.47	...concentrates power in big industrial enterprises

progress," was the second best predictor, adding a surplus amount of 6 percent to the declared variance (P = 0.02). Although the two other risk factors, "potential for threat" and "restriction of social flexibility," correlate highly with the semantic differential (r = 0.80 and 0.81 respectively) they do not add any explanatory power to the multiple correlation coefficient, after Factor II (impacts of large-scale technology) has been included as first predictor.

The predominant concerns in Factors III and IV are thus covered by Factor II, at least in those areas which play a significant role in the formation of this sample's attitudes. It seems evident that potential threat and social risks as highly complex beliefs do discriminate between different attitudinal positions, but are not the underlying reason for this initial formation of positions towards nuclear energy. Rather, both factors are seen as necessary consequences of the perceived negative impacts of large-scale technologies. Respondents who related highly negative impacts with the use of nuclear energy were just as well convinced that the threat for political misuse and for social flexibility was connected with the general impacts of large-scale technologies.

Japan

The factor structure of the Japanese student sample also comprises four factors, again with only one of them referring to beneficial aspects of nuclear energy but three dealing with threats, hazards, and negative impacts (Table VI). However, the factor combining the beneficial aspects occupies first place among all factors. With an eigenvalue of 4.69, it refers mainly to economic advantages such as industrial development, standard of living, and increased employment; thus, Factor I was labelled "economic prosperity." Factor II deals with the "impact on society" from the use of nuclear energy and has an eigenvalue of 3.41. Items with this factor include concerns about the national and international power distribution and health considerations. The third factor, whih combines possible impacts on society in the future has been termed "long-term hazards" and has a relatively low eigenvalue of 2.79.

Factor IV consists of mainly the same items as Factor II of the FRG sample, thus, it has been labelled "potential for threat." This factor also has a quite low eigenvalue (2.57).

Regarding the relevance of these four factors for the attitudinal commitment of this student sample from Japan, "economic prosperity" has the highest correlation (r = 0.64; P 0.01) and therefore takes the first position in the stepwise

Table VI: Factor Structure of Beliefs (JAPAN)

FACTOR LOADING	BELIEF STATEMENT: THE USE OF NUCLEAR ENERGY...
	FACTOR I: Impact on society
.64	...concentrates power in big industrial enterprises
.61	...leads to diffusion of knowledge for construction of weapons
.58	...has an impact on people's health
.55	...leads to environmental pollution
.50	...involves a technology which is a tool in international politics
	FACTOR II: Economic prosperity
.71	...promotes my nation's industrial development
.70	...improves our standard of living
.69	...leads to technological progress
.63	...leads to increased employment
.62	...leads to a more even distribution of income among nations
.61	...increases my nation's prestige
	FACTOR III: Long-term hazards
.76	...restricts options for future societal development
.62	...has a long-term impact on climate
.61	...is harmful to future generations
	FACTOR IV: Potential for threat
.72	...requires management of dangerous wastes
.62	...provides a source of threats from terrorists
.57	...exposes people to hazards which they cannot influence by any actions of their own
.57	...leads to accidents which affect large numbers of people at the same time

Table VII: Multiple Regression of eb Scores

(Most Important Predictors in Descending Order)

		R(changed)
GERMAN STUDENTS		
13.	Having an impact on people's health	.73**
17.	Providing a cheap energy source	.79**
20.	Leading to environmental pollution	.82**
14.	Postponing the development of alternative energy sources	.84
5.	Leading to technological progress	.85
JAPANESE STUDENTS		
5.	Leading to technological progress	.50**
18.	Leading to accidents which affect a large number of people at the same time	.62**
4.	Being harmful to future generations	.69**
10.	Leading to dependency on small groups of specialists	.73**
25.	Leading to increased employment	.75
PHILIPPINE STUDENTS		
1.	Improving our standard of living	.46**
17.	Providing a cheap energy source	.55**
26.	Stimulating scientific and technological	.60**
20.	Leading to environmental pollution	.64**
21.	Restricting options for future societal Development	.65

** Changes in correlation significant (p 0.01)

three top positions. German and Japanese students consider both benefits and risks as decisive for their attitudes.

The Discriminative Power of Weighted Beliefs

The most important question in cross-national surveys is the distinction between typical belief and evaluation patterns which form the basic skeleton of each cultural identity. Identification of attitudes towards energy is certainly too confined as a concept to permit in depth interpretation of cultural and social properties which influence the response patterns to new technologies. But at least the concerns which are predominant in one country compared to the others can be revealed.

In order to detect the main differences between the three samples, discriminant analysis was used. Depending on the parameters used for the statistical calculation, all variables can be ordered according to the degree to which their variance discriminates between the samples. Table VIII shows the results for each item. In the first line the most discriminative item is listed followed by the second most discriminative and so on. In total, 15 items out of 30 proved to be significantly different. This rather large number is a good indication for the relevance of national particularities.

Inspection of Table VIII demonstrates that there are distinct differences with regard to the expected benefits of nuclear energy. Whereas German students emphasize the advantages of cheap energy supply and of conserving natural resources, the Philippine students apparently disregard these two benefits, but are convinced that nuclear energy can increase the industrial development of their country and the national prestige. Those two benefits are considered of no avail to the German students, though. The Japanese respondents lie in between. Similar to the Germans, they regard nuclear energy as an inexpensive way of generating electricity; like the Philippine students, they believe in the incentive role of nuclear energy for the development of the national industry.

Regarding the question of conserving natural resources and increasing national prestige, the Japanese respondents relate both issues to the utilization of nuclear energy, although not as strongly as the German or the Philippine respondents. In contrast to the German and Philippine sample, the Japanese regard nuclear power as a long-term solution to their energy problems. All three samples react more homogeneously on the risk side. But there are still some distinct patterns which are worthwhile mentioning. The Japanese respondents perceive

Table VIII: Discriminant Coefficients and Mean Differences Between the Three Samples

	EB	Lambda	Sig.	Mean German Students	Mean Japanese Students	Mean Philippine Students
1	Conserve natural resources (7)	0.86	0.00	4.42	2.09	-0.37
2	Increase nation's prestige (22)	0.77	0.00	0.09	1.34	2.64
3	Assuring economic independence (12)	0.69	0.00	1.92	1.33	-2.16
4	Technology as tool in international politics(15)	0.65	0.00	-1.28	-1.78	0.29
5	Management of dangerous wastes (6)	0.60	0.00	-0.08	1.73	-2.71
6	Leads to equal income distribution among nations (30)	0.57	0.00	-2.45	-1.14	-0.94
7	Promotes industrial development (3)	0.54	0.00	1.93	3.14	3.58
8	Restricts options for future societal development (21)	0.52	0.00	+2.27	+0.92	+0.31
9	Postpones the development of alternative energy sources (14)	0.49	0.00	-0.22	2.04	-1.15
10	Provides cheap energy (17)	0.48	0.00	2.45	2.59	-1.38
11	Long-term solution to energy needs (19)	0.48	0.00	0.35	2.21	-0.13
12	Restricts personal freedom (2)	0.46	0.00	1.9	1.3	-2.16
13	Leads to environmental pollution (20)	0.45	0.00	-1.95	-2.37	-4.84
14	Leads to proliferation (28)	0.44	0.00	-1.46	-1.35	-0.89
15	Uses up valuable land (9)	0.43	0.00	-1.28	-1.77	0.29

hardly any risk in connection with radioactive wastes; the Germans show medium concern, whereas the Philippine students have a rather negative view on the waste problem. This negative evaluation is also predominant with regard to environmental pollution and, rather unexpectedly, about the restriction of personal freedom. German and Japanese students are less concerned about environmental pollution as a consequence of nuclear power and do not believe that personal freedom might be endangered by the implementation of nuclear power. Only the international threats seem to be more decisive for the German and Japanese negative view of nuclear power. Proliferation is seen as a high probability risk factor by these two samples, whereas the Philippine students are not as much concerned with this possible menace to world peace.

Two more differences should be mentioned. First, the Japanese students do not perceive nuclear energy as a competitor for alternative energy sources but as a complement. Both the German and Philippine respondents believe that the use of nuclear power will restrain the development of alternative energy sources. Second, while the Germans feel that nuclear energy has the potential to increase scientific research, the Philippine respondents reject this possibility, and Japanese respondents are somewhat undecided.

Most of the results fit into a consistent mosaic characteristic for each country. German and Japanese students reflect their industrial heritage by ascribing the role of a promoter of nuclear energy which helps to provide inexpensive electricity, encourage economic progress, and increase national independency. The Philippine sample perceives nuclear energy as an imported technology with rather doubtful economic advantages and high risks. But they do link nuclear energy with some positive symbolic attributes: Increase of prestige as well as encouragement for modernization and industrial development. The motivation to go nuclear is more functional on the German side, more symbolic on the Philippine side. The Japanese respondents react more like the German students; however, in some aspects concerning national prestige and economic development they agree with the Philippine statements. Functional attitudes are typical for highly industrialized western cultures; the Japanese are still partly influenced by traditional value systems, but at the same time highly motivated by modern functional evaluations. If the risk aspects had not had such a strong impact on the Japanese attitudes, their overall judgment combining functional and symbolic aspects would tend to a rather well-balanced and stable attitude towards nuclear energy.

A further interpretation of the results could lead to substantial errors, since proponents and opponents of nuclear energy are not equally distributed in each sample. Thus, some of the differences revealed in the discriminant analysis are due to differences in the overall attitude distribution within the samples rather than to national differences. If one keeps the attitude distribution constant, some of the results would have to be modified. In particular, the social risks of restricting personal freedom and of adding more restraints to a flexible development of society are only related to negative attitudes towards nuclear energy. Therefore, the emphasis of the Philippine sample towards societal risk is not originated by national differences, but caused by the higher frequency of opponents within the Philippine sample. If the distributional effect is eliminated by statistical precedures, there is no significant difference between the three samples with regard to societal and social risks, while all other differences between German, Philippine, and Japanese students were still existent.

The importance of national properties in the attitude formation can further be demonstrated by the predictive power of the two discriminant functions. Using two discriminant functions which represent the differences between the three samples, 71 percent of all cases could be correctly classified. It is indicated that the belief system not only discriminates between proponents and opponents of nuclear energy, but between different national samples.

THE INVESTIGATION OF IMPORTANCES

The objective of this part of the study was to determine the awareness of respondents about the current issues in the nuclear debate. The information derived is intended to give an indication about the informational background of the three samples rather than attitudinal aspects. Table IX gives the mean values of the importance ratings of each attribute for the three samples and the ranks assigned on the basis of the mean values.

Generally, it can be noted that the German students tend to have lower importance ratings than the remaining two samples, who appear to consider a substantial part of the issues presented as relevant in the debate about the use of nuclear energy. Inspection of the ranks as expressions of priorities, however, shows that there is an overall agreement between the three nations. This is also reflected in the rank correlation

TABLE IX: Importance Ratings and Respective Ranks

		PHILIPPINES		JAPAN		FRG	
		means	rank	means	rank	means	rank
1	Improving our standard of living	4.57	13	4.55	13	3.03	20
2	Restricting personal freedom through rigorous security measures	3.89	25	3.27	28	3.06	19
3	Promoting my nation's industrial development	4.64	8	4.24	16	3.54	14
4	Being harmful to future generations	4.62	12	4.73	10	3.58	13
5	Leading to technological progress	4.74	4	4.79	8	4.19	7
6	Requiring management of dangerous wastes	4.56	14	5.44	1	4.54	6
7	Helping to preserve natural resources	4.69	5	4.66	11	5.14	1
8	Providing a source for threats from terrorists	4.06	22	4.08	19	2.79	26
9	Using up valuable land	4.12	23	3.63	25	2.53	28
10	Leading to dependency on small groups of specialists	4.19	21	3.69	24	2.86	22
11	Exposing people to hazards which they cannot influence by any actions of their own	4.66	7	4.55	13	3.43	16
12	Assuring the economic independence of my country	4.56	14	3.80	23	4.07	8
13	Having an impact on people's health	5.13	1	4.92	6	3.73	11
14	Postponing the development of alternative energy sources	3.76	28	3.20	29	2.85	23
15	Involving a technology which is a tool in international politics	4.25	20	4.12	18	2.83	25
16	Having a long-term impact on climate	4.30	19	4.49	15	3.22	18
17	Providing a cheap energy source	4.41	17	5.01	2	4.60	5
18	Leading to accidents which affect large numbers of people at the same time	4.83	3	5.00	3	3.71	12
19	Being a long-term solution to energy needs	4.63	9	4.81	7	5.07	2
20	Leading to environmental pollution	4.63	9	4.76	9	3.79	9
21	Restricting options for future societal development	4.83	18	3.57	26	3.03	20
22	Increasing my nation's prestige	3.53	29	2.51	27	2.11	30
23	Leading to a consumption-oriented society	3.46	30	3.10	30	2.27	29
24	Concentrating power in big industrial enterprises	3.99	24	3.86	22	2.65	27
25	Leading to increased employment	4.68	6	4.66	11	4.81	3
26	Stimulating scientific and technological research	4.98	2	5.00	3	4.79	4
27	Reducing the need to conserve energy	3.89	25	3.89	21	3.46	15
28	Leading to diffusion of knowledge for construction of weapons	3.77	27	4.18	17	2.84	24
29	Involving hazardous agents which cannot be detected by man's senses	4.63	9	4.98	5	3.74	10
30	Leading to a more even distribution of income among nations	4.45	16	3.99	20	3.74	10

coefficients, which demonstrate a highly significant concordance of priorities (Philippines - Japan: $r = 0.79$, Philippines - FRG: $r = 0.77$, Japan - FRG: $r = 0.72$).

Taking the first four top ranking issues for each sample, it can be seen that Philippine and Japanese respondents want risks and benefits of nuclear energy to be discussed whereas FRG respondents mainly are interested in the benefits. With regard to the priorities expressed by Philippine students, they have focused their attention on potential health impacts and large accidents on the risk side, and on stimulation of scientific and technological research and progress on the benefit side. Japanese are also attentive to the potential of large accidents and to research in science and technology, but furthermore deem more elaborate discussions on waste management and on economic ways to produce necessary energy. In the FRG, students appear to be concentrating their attention on the beneficial aspects of generating energy with nuclear power, with conservation of natural resources, long-term solutions to energy needs, increased employment, and stimulation of research amongst their top priorities. This might be interpreted as an indication of their interest to hear more about the benefits operational nuclear power plants will ensure rather than being overwhelmed with information about risks being reduced.

Regarding the lowest priorities assigned by the three samples, they all agree that a concern about consumption-oriented society is negligible and that their nation's prestige is not at stake in the debate about nuclear power. Furthermore, the often heard argument that advancement of nuclear energy might lead to a shortage of funds and interest for development of alternative energy sources does not appear to be a relevant issue.

SUMMARY AND CONCLUSIONS

We presented a case study of an empirical investigation using the Fishbein attitude model to reveal the underlying dimensions of people's perception of nuclear energy. We compared the belief structure of each sample, tried to reveal the most significant factors that influence the general attitudinal commitment, and searched for major differences between the three nations. What results did we find and how can they be interpreted? Let us first summarize the most important findings:

1) The three student samples differ in their composition of pro- and anti-nuclear points of view. The Japanese students were predominantly in favor of the use of nuclear energy; the German students were divided in their attitudinal structure, but with the majority on the pro-nuclear side, whereas the Philippine student sample showed the most anti-nuclear resentments. Since the size of the three samples does not permit any inference about how representative the distribution of attitude is compared to the attitude of all students in each country, the difference between the three samples might be due to sampling distortions as to real national discrepancies.

2) Looking at the scores of the semantic differential, the response pattern of the three samples is supported by the primary analysis of the attitude distribution. The more favorable Japanese respondents see nuclear energy as very important, useful, modern, and worthwhile, assigning only a few negative attributes (controversial and slightly dangerous) to this energy technology. In contrast, Philippine students view nuclear energy as quite wrong, oppressing and useless, conceding, though, that this energy source might be important for the future. The German students perceive nuclear energy as quite modern and useful, but also as dangerous.

3) A closer examination of the belief stucture using factor analysis revealed three to four basic dimensions which account for the variance of most of the 30 single items. The Japanese students have some concerns about indirect impact on society (such as power concentration or proliferation), long-term hazards (such as harm for future generations), and potential for threat (such as accidents with large numbers of affected people), but perceive at the same time quite a potential for economic prosperity. The German students are also concerned about the negative impacts of large-scale technologies and the potential for threat. Furthermore, they are concerned about the restrictions of social flexibility (such as dependency on small groups of experts). Like the Japanese students, they also emphasize the benefit of nuclear power

concentrating on its positive effect towards economic progress. The Philippine sample put more emphasis on the negative impacts of large-scale technologies than the other respondent groups, but perceived also some progress in national development and indirect fringe benefits which might or might not be associated with the extension of nuclear power.

4) The division into various underlying dimensions does not necessarily provide any conclusions about the importance of those factors with respect to the overall attitude of the respondents. Regression analysis was used to investigate the salient beliefs which are decisive for attitudinal commitment. The regression analysis revealed a rather ambiguous picture: the attitudes of all these groups were influenced by positive and negative items simultaneously. Direct advantages, such as cheap energy, and disadvantages, such as health effects or pollution, turned out to be the most important items for the attitude of the German students. More indirect advantages, such as technological progress and employment, and disadvantages (such as being harmful to future generations or affecting a large number of people) are underlying determinants for the attitude structure of the Japanese sample. It was surprising that almost only positive benefit items govern the direction of attitudes of the Philippine sample, in spite of their more negative view towards nuclear power, since there was a universal agreement among all Philippine students that nuclear energy is dangerous and risky. For this reason only the perception of benefits discriminates between positive and negative attitudes.

5) Discriminant analysis was used to detect the main differences between the three national samples. Concerning the benefits of nuclear power, the German students emphasized the advantages of cheap energy supply and of conserving natural resources--two aspects which are less relevant for the Philippines. Rather, the Philippine students are convinced that nuclear energy increases the industrial development of their country and the national prestige--these two aspects have no relevance for

the German students. The Japanese respondents give credit to all four aspects. Concerning the risk side, the samples reacted more homogeneously. All respondents are worried about health effects and the waste problem; the Philippine students were most concerned. Political risks such as proliferation are more typical for the two industrialized countries (Germany and Japan), whereas social risks, such as the potential threat to personal freedom, were quite predominant for the Philippine sample.

6) The importance of national properties could be demonstrated by the predictive power of the two discriminate functions which represent the differences between the three samples. The discriminative power of the belief items was higher between the three national samples than between the pro and con groups of the combined samples. How economic advantages and personal and social risks are perceived with respect to nuclear power seems to depend much more strongly on national properties than on favorable or unfavorable positions. Although the protest against nuclear energy is international, the arguments and basic evaluation appear to considerably differ between various contries. Thus, it seems necessary to study these national properties more closely in order to investigate the social factors which influence the national perception of nuclear power.

7) Considering the importances of each belief item, there are only four differences among the three samples. With regard to the priorities, the Philippine students focused their attention on potential health impacts, large accidents (risk side), and on the stimulation of research and progress (benefit side). Japanese students were also attentive to the potential of large accidents and to research in science and technology, but were concerned about waste management and energy supply. German students concentrated their attention on the beneficial aspects of nuclear power, ranging from economic advantages to conservation of natural resources.

What kind of general conclusions can be drawn from these results? First, it seems apparent that all respondents agree that nuclear power can be associated with direct health risks,

but also with political and social threats which are due to the perceived impacts of large-scale technologies. Whereas in the German sample both risk levels are highly intercorrelated, the two other samples differentiated between the two levels. There was hardly any argument between the pro- and anti-nuclear groups about the direct risks, including the long-term hazards and the waste problem. But if the indirect risks, like social threats for personal freedom or political risks of proliferation, were seen as a major consequence of nuclear energy, a negative attitude was likely to be formed.

But the most salient beliefs mainly cluster around the benefit items. Again, with the exception of the German students --exposing a predominantly technical point of view--the economical or financial aspects were less important as opposed to the indirect incentives to improve the employment rates, the development of industry, and the long-term supply situation. Thus, the purely instrumental advantages proved to be insufficient to compensate for the perceived risks. If the respondents were not convinced that in the long run the economy and the native society would benefit from the use of nuclear power, their attitudes were at least ambiguous, if not negative.

There were clear cut differences between the three nations. The German students had the most pragmatic approach to the nuclear issue. They were concerned about health risks, waste disposal and pollution, somewhat worried about proliferation, and influenced by economic aspects, such as energy prices or technological progress. The Japanese did take these direct impacts of nuclear energy into account, but concentrated on the risks of large-scale technologies and their indirect benefits. In particular, elements of progress and national prestige were relevant, assigning some symbolic value to the nuclear technology. The students from the Philippines focused their attention on the indirect and symbolic aspects of nuclear power. Being dependent on the delivery of power stations from abroad, nuclear energy was not perceived as an instrument for national independence or self-reliance. Positive symbolic attributes refer to the improvement of the standard of living, national prestige, or the stimulation of scientific progress. If these benefits were not regarded as probable, the negative view on the risk aspects, ranging from the waste problem to the potential threat to personal freedom, outweighed the positive beliefs. Thus, according to our analysis it does not seem surprising that the Philippine sample was characterized by the percentage of negative attitudes.

A lot of questions remain to be answered. What are basic values which determine the genesis of specific beliefs? Why do people differ in various countries? How is the attitude of

nuclear power connected with perceptions of other technologies or technological change in general? One survey cannot answer all these questions. We hope that our investigation will encourage new research in this area and that these studies will serve as a mosaic stone in the evaluation of scientific knowledge about man and technology.

REFERENCES

1. O. Renn, Man, Technology, and Risk, (Jul-Spez-115, Reports of the Nuclear Research Centre Julich, 1981), or M. Douglas and A. Wildavsky, Risk and Culture (University of California Press, Berkeley, San Francisco, 1982).

2. K.R. Hammond, G.H. McCleeland, and J. Mumpower, Human Judgment and Decision Making (Praeger Special Studies, Hemisphere Publishing Corp., Boulder, Col. 1978).

3. A. Tvevsky and D. Kahneman, The Framing of Decision and the Psychology of Choice, Science, 211, 453-458 (1981).

4. J.L. Janis and L. Mann, Decision Making (The Free Press, New York, 1977).

5. H.J. Otway, Perception and Acceptance of Risks, Zeitschrift fur Umweltpolitik, 2 (1980) pp. 593-616.

6. O. Rammstedt, Was heibt soziologisch Risiko? Manuscript for the Workshop: Analysis, Evaluation and Acceptability of Hazardous Technologies and Their Risks. (Berlin, Dec. 14-15, 1981).

7. J. Hoos, "Risk Assessment in Social Perspective", in Perception of Risk, Proceedings of the 15th Annual Meeting, National Council on Radiation Protection and Measurements, eds. (Washington D.C. 1980), pp. 57-84. For a special application on energy systems, see: R. Caputo, World in Collisions: Is a Rational Policy Possible for Countries in West Europe? (Manuscript, California Institute of Technology, Pasadena (1983) prepared for Energy Policy.

8. O. Renn and E. Swaton, Psychological and Sociological Approaches to Study Risk Perception (Manuscript, Invited Paper for the Workshop ENVIRISK 83, San Miniato, June 22-24, 1983).

9. H. Jungermann, "Introduction: Decision Making in Theory" in Psychologische Entscheidungstheorie, Wayne Lee, author (Beltz, Weinheim, Basel 1977) pp. 9-37.

10. M. Rokeach, Beliefs, Attitudes and Values (San Francisco 1969).

11. O. Renn and H.P. Peters, "Intuitive Risk Perception: Research Results of Attitude Survey Towards Risk and Technology" in Proceedings of the International ANS/ENS Topical Meeting on Probabilistic Risk Assesment, American Nuclear Society ed. (Port Chester, Sept. 20-24, 1981), pp. 1464-1480.

12. C. Kluckhorn, "Values and Value Orientations in the Theory of Action", in Toward a General Theory of Action, T. Parsons, E. Shils eds., (New York and Evanston 1962) pp. 388-433.

13. M. Fishbein and I. Ajzen, Belief, Attitude, Intention and Behaviour: An Introduction to Theory and Research (Addison-Wesley, Reading, Mass., 1975).

14. G.W. Allport, "Attitudes", in Handbook of Social Psychology, C. Murchinson ed. (Clark University Press, Worcestar 1935) pp. 798-844.

15. W.J. McGuire, "The Nature of Attitudes and Attitude Change", in Handbook of Social Psychology, G. Lindzey and E. Avanson, eds. (Vol. III, Addison-Wesley, Reading, Mass. 1969) pp. 136-314.

16. M.L. De Fleur and F.R. Westie, Verbal attitudes and event acts: An experiment on the salience of attitudes. American Sociological Review 23 (1958) pp. 667-673.

17. W. Meinefeld, Einstellung und soziales Handeln, (UTB, Reinbek bei Hamburg 1977).

18. M.E. Shaw and J.M. Wright, Scales for the Measurement of Attitudes (McGraw-Hill, New York 1967).

19. D. Krech, R.S. Crutchfield and E.L. Ballachey, Individual in Society (McGraw-Hill, New York 1962).

20. M.J. Rosenberg, Cognitive structure and attitudinal affect, Journal of Abnormal and Social Psychology 53 (1956) pp. 367-372.

21. M. Rokeach, "The nature of attitudes", in International Encyclopedia of the Social Sciences, vol. 1 D.L. Sills, ed. (New York, 1968) pp. 449-458.

22. H.C. Triandis, "Toward an Analysis of the Components of Interpersonal Attitudes", in Attitude, Ego-Involvement and Change, C.W. Sherif and M. Sherif, eds. (Wiley, New York 1967) pp. 227-270.

23. V.H. Vroom, Work and Motivation (New York 1964).

24. Reference No. 18 and C. Murphy, L. Murphy and T. Newcomb, Experimental Social Psychology (Harper & Row, New York, 1937).

25. M. Fishbein, An Investigation of the Relationships between Beliefs about an Object and the Attitude toward that Object. Human Relations 16 (1963) pp. 233-240.

26. M. Fishbein and I. Ajzen, Belief, Attitude, Intention and Behaviour. An introduction to theory and research (Addison, Wiley, Reading, Mass. 1975).

27. H. Otway, Perception and Acceptance of Risks, Zeitschrift fur Umweltoplitik 2 (1980) p. 97.

28. A.W. Wicker, Attitudes vs. Actions: The relationship of verbal and event behavioural responses to attitude objects. Journal of Social Issues 22 (1969) pp. 41-78.

29. C. Osgood, G. Suci, and P. Tannebaum, The Measurement of Meaning (University of Illinois Press, Urbana 1957).

30. J.J. Otway and M. Fishbein, Public Attitudes and Decisionmaking (RM-77-54, Laxenburg, Austria, International Institute for Applied Systems Analysis, 1977).
or:
K. Thomas et al. Comparative Study of Public Beliefs about Five Energy Systems (RR-80-15, Laxenburg, Austria: International Institute for Applied Systems Analysis, 1980).

31. Reference on No. 30 and K. Thomas et al., Nuclear Energy: The Accuracy of Policy-Makers Perception of Public Beliefs (RM-80-18, Laxenburg, Austria: International Institute for Applied Systems Analysis, 1980).

32. E. Swaton and O. Renn, Attitudes towards Nuclear Power. A Comparison between Three Nations (RM-X-83, Laxenburg, Austria, International Institute for Applied Systems Analysis, in press).